

Relative effectiveness of individual sunflower traits for reducing red-winged blackbird depredation

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ABSTRACT. The influence of sunflower head shape and bract orientation on feeding preferences of red-winged blackbirds (*Agelaius phoeniceus* L.) was examined. Only concave or near-flat sunflower heads orientated in a ground-facing position consistently received little bird damage. Bract orientation did not influence feeding. Development of bird-resistant sunflower cultivars may represent a cost-effective strategy to reduce blackbird depredation to sunflower.

KEYWORDS: *Agelaius phoeniceus*; bird resistance; blackbirds; seed preference; sunflower

Introduction

Blackbird depredation on sunflowers is economically significant in the Coteau physiographic region of the Northern Great Plains in North America (Hothem, DeHaven and Fairazl, 1988; Linz *et al.*, 1989). One promising method for reducing damage is the development of bird-resistant varieties involving both chemical and morphological characteristics that thwart blackbird feeding (Parfitt, 1984; Parfitt and Fox, 1986). Morphological features that may make sunflower achenes less accessible to feeding blackbirds include concave heads facing downward, thicker hulls, long head-to-stem distance, and long inward-pointing bracts. Chemical features that may confer resistance include high levels of anthocyanin in sunflower achenes (Mason *et al.*, 1986).

An experimental variety of bird-resistant sunflower, i.e. Bird Resistant Synthetic (BRS), has been produced by the Department of Crop and Weed Sciences, North Dakota State University. BRS emphasizes morphological resistance (e.g. concave head facing downward, thicker hulls, long head-to-stem distance and long bracts). In field tests, BRS is bird resistant, but only when susceptible oilseed sunflowers are available near the experimental field (Dolbeer *et al.*, 1986; Mah, 1988). These data may reflect only the lower yield and oil content of these bird-resistant sunflower genotypes relative to the susceptible oilseed hybrids (Ball, 1984). Breeding procedures are currently under way to improve the agronomic quality of the bird-resistant

genotypes. Knowledge of the efficacy of traits deterring bird depredation may expedite the development of bird-resistant genotypes that will be used in production of hybrids. The objective of our experiments was to evaluate the relative effectiveness of individual bird-resistant features possessed by BRS.

Materials and methods

Seven experiments were conducted in 1987 and 1988 (27 August to 10 September) to assess preferences exhibited by red-winged blackbirds for BRS possessing different bird-resistant traits (Table 1). Experiments were performed to evaluate the importance of head shape and bract orientation in BRS.

Hatching-year male red-winged blackbirds were decoy-trapped in August and acclimatized in an outdoor holding cage (10 × 10 × 2.5 m) on the grounds of the Fargo Experiment Station for at least 14 days. At any one time, the holding cage contained ≈ 60 birds. Before experimentation, 18 birds (> 65 g) were selected randomly and housed individually in cages (1.5 × 1.5 × 2 m). Except as described below, commercial turkey-feed mixed with sunflower seeds (other than the varieties tested) was provided *ad libitum* in cups positioned on top of stands, 1.5 m high, 1 m apart, in the centre of each cage. Water and grit were provided *ad libitum* in pans.

Sunflowers having the desired phenotypes were selected from large sunflower populations of BRS. Exaggerated head shapes which were atypical to the

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TABLE 1. Description of experiments designed to test for differences in seed consumption between sunflower heads different only in the traits indicated

Expt no.	Genotype description ^a	Bird-resistant traits represented	Bird-resistant traits tested
1	CC-BRS CX-BRS	DN + head shape + NB DN	Head shape
2	CC-BRS-DN-NB CX-BRS-DN-NB	DN + head shape + NB DN	Head shape
3	CC-BRS-DN-OB CX-BRS-DN-IB	DN + head shape + OB DN + head shape + IB	OB vs. IB
4	CX-BRS-DN-OB CX-BRS-DN-IB	DN + OB DN + IB	OB vs. IB
5	CC-BRS-DN-IB CX-BRS-DN-IB	DN + head shape + IB DN + IB	Head shape
6	CC-BRS-DN-OB CX-BRS-DN-OB	DN + head shape + OB DN + OB	Head shape
7	CC-BRS-UP-NB CX-BRS-UP-NB	UP + head shape UP	Head shape

^aCC, concave head shape; CX, convex head shape; BRS, Bird Resistant Synthetic; DN, head facing downwards; UP, head facing upwards; NB, bracts removed; OB, outward-pointing bracts; IB, inward-pointing bracts

genotypes, i.e. convex BRS, were compared with typically shaped heads. Sunflowers possessing particular traits were tested in pairs. Other non-tested traits such as height, head size and angle of the head in each pair were matched. Unless otherwise noted, all bracts and leaves adjacent to the head were removed before it was placed in the cages, to encourage birds to perch on top of the head while pecking the seed – a typical feeding position used by free-living red-winged black-birds (Mah, 1988). All flowers were tested in a natural growing position (i.e. head facing downward), with petals and bracts removed. The plants were uprooted and held upright by racks in water pails (5 gallons, ≈22.5 l) to prevent the heads from wilting. Sunflowers were placed in the cages before dark (1800–1900 h) and remained as the only food for the resident bird for 24 h. Between trials, the birds were placed on maintenance food for at least 24 h. Characteristics were tested in random order to reduce possible biases due to the order of tests.

Experiment 1

Convex and concave (including flat or near-flat heads) BRS heads were paired to test the efficacy of concave head shape (Table 1). Convex heads were defined as those in which the rims were recessed by at least 2 cm when compared with the centres. The procedures used for experiments 2–8 were altered so that 25 individually housed birds were used per experiment and head shape of the tested sunflowers was quantified as a diopetre number (D), a unit reflecting the curvature of spherical surfaces. A diopetre of 0 is flat, while increasing positive numbers reflect increasing convexity, and increasing negative numbers reflect increasing concavity. The diopetre number

of a sunflower head was computed from the following formula:

$$D = 2 \times \{ [(a^2 + b^2)b^2/a^2] + (a^2 + b^2) \}^{-\frac{1}{2}}$$

where *a* is the radius of sunflower head (m), and *b* is the height of the centre elevation from the plane containing the rim of the head (m) (*b* = 0 when head is flat).

Experiment 2

This experiment was a replication of experiment 1 (Table 1).

Experiments 3 and 4

To test the effects of bract orientation, BRS pairs having inward- and outward-pointing bracts were used (Table 1). Convex heads were used in experiment 3, whereas concave heads were used in experiment 4.

Experiments 5 and 6

To test head shape effects in conjunction with bract orientation, convex and concave heads with inward-pointing bracts were used in experiment 5 and with outward-pointing bracts in experiment 6 (Table 1). Heads faced downward in these experiments.

Experiment 7

To test head shape effects on upward-facing sunflowers, convex and concave sunflower pairs were used, facing upwards, with bracts removed (Table 1). Typical BRS has long and outward-pointing bracts and downward-facing heads. The inward-pointing bracts were created artificially by wrapping BRS heads with plastic net-bags for at least 2 weeks before testing. When upward-facing heads were needed, the head was twisted upward and fixed to the racks in the testing cages with twine.

Data analysis

Seed consumption from sunflower heads was measured using a template method (Dolbeer, 1975). Paired *t* tests were used to evaluate the results of each experiment.

Results

The experiments revealed that concavity was associated with bird resistance (experiments 1, 2, 5, and 6, Table 2). Experiments conducted in 1988 when head shape was measured quantitatively indicated that only sunflower with concave to near-flat heads (*D* < 0 or *D* ≈ 0) were bird resistant (experiments 2, 5, and 6, Table 2). Orientation of bracts did not affect the bird resistance of either convex or concave BRS heads (experiments 3 and 4, Table 2).

TABLE 2. Comparisons of bird-resistant effectiveness of sunflower traits

Expt no.	Genotype description ^a	n	Head shape (dioptries)		Seed consumed (cm ²)		Difference in seed consumed (cm ²)		<i>p</i> > <i>T</i> ^b
			\bar{x}	s.e.	\bar{x}	s.e.	\bar{x}	s.e.	
1	CC-BRS	18	—	—	10.0	3.2	—65.8	5.1	0.0001
	CX-BRS	18	—	—	75.8	6.2			
2	CC-BRS	25	-1.6	0.5	23.6	4.3	-27.3	8.6	0.0042
	CX-BRS	25	8.4	0.5	50.8	5.1			
3	BRS-IB	25	11.2	0.6	21.6	3.5	-1.1	6.4	0.8646
	BRS-OB	25	10.9	0.5	22.7	3.8			
4	BRS-IB	23	-2.8	0.6	15.8	3.9	-5.4	6.6	0.4184
	BRS-OB	23	-1.2	0.7	21.2	4.5			
5	CC-BRS	9	0.5	1.4	8.3	3.7	-17.2	7.4	0.0492
	CX-BRS	9	10.1	1.2	25.6	5.5			
6	CC-BRS	19	1.2	1.1	11.6	2.9	-14.2	5.1	0.0123
	CX-BRS	19	10.0	0.5	25.8	3.2			
7	CC-BRS	20	-0.8	0.4	21.1	2.9	-2.3	4.8	0.6426
	CX-BRS	20	6.5	0.4	23.4	2.9			

^aCC, concave head shape; CX, convex head shape; BRS, Bird Resistant Synthetic sunflower genotype; IB, inward-pointing bracts; OB, outward-pointing bracts;

^bdifferences in seed consumption on heads within experiment were tested using a paired *t* test

Concave head shape appeared to be the most effective trait for conferring bird resistance to sunflower. However, it was consistently effective only when the flowers were facing downward (experiments 2, 5, and 6, Table 2). Bird resistance based on this feature became ineffective when flower heads were facing upward (experiment 7, Table 2).

Discussion and management implications

Data on blackbird feeding behaviour (Mah, 1988) suggest differences in the importance of various bird-resistant traits. The effects of some bird-resistant features of BRS, such as head-to-stem distance (Seiler and Rogers, 1987; Mah, 1988) may have no effect on bird feeding. The effectiveness of these features for thwarting blackbird feeding, individually and in combination, is not clear.

Convex-shaped sunflower heads were preferred over concave-shaped or nearly-flat heads when facing the ground. Our results suggest that the concave-shaped or nearly-flat heads appear to be at the threshold of being effective in conferring bird resistance. Moreover, concave-shaped heads were not bird resistant unless the heads faced downwards.

Our results provide direct support for the hypothesis that some sunflower morphological traits may reduce the preference for sunflower seed by feeding blackbirds. The concave head shape and some characteristics related to BRS hulls may confer bird resistance. However, in their present forms, none of the morphological traits provide complete protection from blackbird depredation.

In summary, three issues remain to be explored before the use of bird-resistant sunflower cultivars as a tool for controlling bird depredation can be justified.

First, because none of the BRS traits confers complete bird resistance, the maximum protection that could be provided by accentuating certain traits or combination of traits must be ascertained. Second, blackbirds prefer sunflower varieties with high oil content, e.g. Hybrid 894, to one with lower oil content, e.g. BRS. How much of this preference is due to oil content of the seeds and how much is due to morphological resistance traits is not clear. Thus, it cannot be predicted whether blackbirds will prefer 894 over BRS when the nutritional content of BRS is improved by increasing oil content. Third, bird resistance measurements resulting from paired sunflower tests only provide relative information that relates to the sunflower counterparts that they are compared against. Similarly, the bird resistance of sunflower is relative to the 'resistance' of alternative food available to the birds.

Acknowledgements

The authors are grateful to Drs J. W. Grier, G. L. Nuechterlein, J. R. Mason and two anonymous reviewers for reviewing early manuscript drafts. Drs D. Hertsgaard and R. B. Carlson assisted with the statistics. G. B. Mowery, T. Johnson and B. Osborne provided technical assistance. This study was sponsored by USDA, APHIS contract 12-34-41-0020 (CA) and the Departments of Crop and Weed Sciences and Zoology, North Dakota State University.

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Received 3 January 1990

Revised 30 March 1990

Accepted 11 April 1990